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April 15, 2010 CDM Project File: 5000-55353

Ms. Ana Townsend
California Regional Water Quality Control Board - Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, California 90013

Subject: **Workplan – Well Installation and Aquifer Performance Tests**
Former C-6 Facility
1451 – 1452 West Knox Street, Los Angeles, California

Dear Ms. Townsend:

On behalf of The Boeing Company (Boeing), Camp Dresser & McKee Inc. (CDM) has prepared this Workplan describing the scope of work for extraction and monitoring well installation, development, and sampling, and for conducting aquifer performance tests (APTs) at the Former C-6 facility in Los Angeles, California.

1.0 Project Background

1.1 Site Location and History

The Former C-6 Facility (Site) is located to the southwest of the 405 and 110 freeway junction, in the city of Los Angeles, California (**Figure 1**). The current area of interest at the Facility (Parcel C) is bounded by a shopping center and 190th Street to the north, shopping center, Normandie Avenue, and former industrial parcels, including the Del Amo Superfund site (Del Amo) to the east, Francisco Street and former industrial parcels, including the Montrose Chemical Superfund site (Montrose) to the south, and Harborgate Way and the former Industrial Light Metals (ILM) site to the west. The Facility is divided by Knox Street into a northern portion (Former Building 1/36 area) and a southern portion (Former Building 2 area). A Site plan is included as **Figure 2**. The surrounding area is primarily industrial and commercial.

Between approximately 1952 and 1992, the Site was used for aerospace manufacturing operations. Operations at the Site ceased in the mid-1990s, the buildings were demolished, and the parcels were sold (except for Building 1/36 area) and redeveloped for commercial/light industrial uses. Environmental studies conducted at the Site since the 1980s indicate that groundwater beneath the Site contain volatile organic compounds (VOCs). In general, two VOC groundwater plumes have been identified at the Former C-6 facility (Former Buildings 1/36 and 2). The primary VOCs detected in the groundwater beneath the Former Building 1/36 area are trichloroethene (TCE), 1,1-dichloroethene (1,1,-DCE), methyl ethyl ketone (MEK [2-butanone]), toluene, and acetone. The Former Building 2 primary VOCs include TCE and 1,1,-DCE. Other VOCs are present in both areas but at lower concentrations. These VOCs have been the focus of past and continuing remediation efforts at the site.

1.2 Site Geology and Hydrogeology

The Site is located in the West Coast Subbasin of the Coastal Plain of Los Angeles Groundwater Basin. Specifically, the Site is located on the Torrance Plain physiographic area of the West Coast Subbasin and is underlain by the Lakewood Formation. The Lakewood Formation is subdivided into two principal hydrostratigraphic units: the Bellflower unit and Gage aquifer. The Bellflower unit is further subdivided into the following:

- Upper Bellflower aquitard (UBF)
- Middle Bellflower B-Sand (MBFB or B-Sand)
- Middle Bellflower Mud (MBFM)
- Middle Bellflower C-Sand (MBFC or C-Sand)
- Lower Bellflower aquitard (LBF)

Groundwater at the Site is encountered at depths of approximately 55 to 65 feet below ground surface (bgs) in the relatively permeable sediments of the Bellflower unit. The B-Sand is found between approximate depths of 55 to 70 feet bgs at the Site and is generally 25 to 40 feet thick consisting of predominantly interbedded fine sands and silts. The C-Sand, consisting largely of interbedded very fine sands with silt and clay, is found at approximate depths of 90 to 110 feet bgs at the site and extends to depths of 120 to 140 feet bgs. The Gage aquifer, comprising largely of sand, occurs in the Site vicinity at an approximate depth of 150 feet bgs and ranges in thickness from 40 to 50 feet.

Additional information on Site geology and hydrolgeology can be found in the 2010 Groundwater Monitoring Work Plan (Avocet Environmental, Inc. [Avocet], 2010) and other reports referenced in the same document.

1.3 Objectives

The main objective of the proposed work is to obtain additional field hydrogeological data to understand hydraulic characteristics and assist in evaluation of remedial options.. The specific objectives are as follows:

- Obtain site-specific data on aquifer hydraulic conductivity, transmissivity, storativity, and aquitard leakage (as appropriate) in the B-Sand, C-Sand and Gage aquifer
- Provide additional information to aid in the design of potential future remedy
- Collect additional soil and groundwater data from newly-installed wells..

1.4 Scope

The overall scope of work is anticipated to consist of the following major components:

- Drilling, sampling, construction, development of six wells in C-Sand, three wells in B-Sand, and one well in Gage aquifer, for a total of 10 wells (**Figure 2**)
- Performance of APTs, including long-term (approximately 24 hours) and short-term (approximately four hour) tests, in eight of the 10 new wells and one existing B-Sand monitoring well
- Collection and analyses of the APT data
- Preparation of a summary report documenting the field activities and data collection/analyses

The remainder of the Workplan provides a description of the procedures to be used during well installation, development, and sampling, and the APTs, and associated permitting, pre-field activities, data collection/analyses, and reporting activities.

It should be noted that the final number of wells installed and the proposed APTs may be reduced based on results obtained during the field activities.

2.0 Pre-Field Activities

2.1 Agency Permits/Notifications

Prior to initiating drilling activities, applications for well construction permits will be completed and filed with the Los Angeles County Department of Health Services (DHS) for all wells to be constructed. Appropriate notifications will be completed to allow for required DHS inspections.

Prior to beginning the field work, appropriate notifications will be made to the California Regional Water Quality Control Board, Los Angeles Region (LARWQCB), property owners/tenants, and other parties.

2.2 Health and Safety

During Site operations, all personnel will follow procedures and safeguards which will be described in a Site-specific Health and Safety Plan (HASP). The HASP will be prepared in accordance with Title 29 CFR, Section 1910.120 and 8 CCR 5192 and will describe the controls and procedures that will be implemented to minimize any incidents, injury, and health risks during on-site activities. The HASP will assign responsibilities, establish personnel protection standards and mandatory safety procedures, and specify appropriate measures and procedures taken for contingencies that may arise while operations are being conducted at the site. The HASP will be specific to the well installation and APT activities proposed at the Site.

During the first day of field activities (prior to beginning any work), contractor and subcontractor personnel and key Boeing management staff will participate in a health and safety kickoff meeting at the Site, where the contents of the HASP will be discussed with all personnel present.

2.3 Underground Utility Clearance

Prior to any intrusive work, utility information, including maps of the existing buildings and remediation infrastructure, will be reviewed and a Site visit will be conducted to locate utilities, mark well locations, and determine Site clearing needs for drill rig access. The proposed locations will be marked on the ground with white spray paint and Underground Service Alert (USA) will be notified a minimum of two working days in advance to allow adequate time for marking the locations of subsurface utilities. In addition, the following precautions will be taken at the Site:

- Three locations will be hand-augered to approximately 10 feet bgs in a triangular pattern around each of the proposed well locations for further utility clearance.

- A geophysical survey will be conducted around each boring location to further verify locations of underground utilities.

3.0 Well Design and Installation

The proposed well locations for B-Sand, C-Sand, and the Gage aquifer are shown on **Figure 2**. Final well locations will be based on the results of the utility clearance activities described in Section 2.3 and any access constraints. **Table 1** provides a summary of the proposed well construction details along with a brief rationale for the proposed well locations.

The sonic rotary drilling technique is proposed for the well installations. This technique utilizes a sonic rotary drill rig to simultaneously rotate, vibrate and axially advance a drive casing to the desired depth. A core barrel sampler is advanced ahead of the drive casing to collect continuous core samples of the lithology.

A telescoping approach is planned for drilling and installation of C-Sand and Gage wells. The telescoping procedure consists of installing a series of successively smaller diameter drive casings into underlying confining units to minimze potential migration of contaminants from upper to lower aquifers. For the C-Sand wells, a 10 or 12-inch diameter drive casing will be advanced through the B-Sand (approximate depths ranging from 75 to 90 feet bgs) and into the MBFM, sealing off the B-sand to minimize potential cross-contamination from the B-sand to the C-Sand . Once the outer casing is set and sealed, an 8 or 9-inch diameter drive casing will be advanced within the outer casing, through the C-sand, and into the LBF. Similarly for the Gage aquifer well, a series of telescoped casings will be advanced to the Gage/Lynwood aquitard to seal off the MBFM and LBF (approximate depths ranging from 120 to 150 feet bgs to minimize potential downward migration of contaminants from B-sand and C-sand. Actual sizes of the casings and any changes/modifications to the proposed methodology will be documented in the final summary report.

Section 3.2 describes the sample collection methods using sonic rotary drilling techniques.

3.1 Well Design

Well design and installation shall meet the applicable DHS requirements and California Department of Water Resources (DWR) well standards. The following paragraphs summarize the procedures to be used during the construction of the wells.

- Three B-Sand wells (EWB003, IWB001, and IWB002) and four C-Sand wells (EWC003, EWC004, IWC003, and IWC004) will be constructed of 5-inch outside diameter (OD) Type 304L stainless steel well screen. The Gage aquifer well (EWG001) will be constructed of either a 5-inch or 6-inch diameter Type 304L stainless steel well screen. The remainder of each well will be completed with 5-inch OD blank, schedule 40 PVC casing, with the except of the Gage aquifer well , which will utilize 5-in or 6-in OD schedule 80 PVC blank casing to accommodate the greater installation depth. The casing for the Gage well (and other wells as appropriate) will be centered in the boring using centralizers placed at each end of the well screen and at other intervals, as appropriate.

- The remaining two C-Sand wells (MWC025 and MWC026) will be constructed of 2-inch (OD), schedule 40 PVC, mill slot screen. The remainder of these two wells will be completed with 2-inch OD, schedule 40 blank PVC casing.

- All the wells are anticipated to be screened entirely across their respective hydrostratigraphic units. The B-Sand wells will be completed with approximately 30 feet of screen; the C-Sand wells will be completed with approximately 25 feet of screen; and the Gage well will be completed with approximately 30 feet of screen. Final boring and screened depths and screen intervals will be based on lithologic observations.

- The final screen slot size for all the wells will be selected on a case by case basis, based on the lithology encountered and gradation of the chosen filter pack. Similarly, the size and gradation of the filter pack will be selected by the onsite geologist based on field observation and sieve analyses of the formation samples. Based on available data, the following sizes of screen and filter packs are anticipated to be used. Wells with a large proportion of fine-grained material (e.g., silt and fine sand) will be completed using 0.010-inch (10–slot) screen and #2/12 (12 x 20 blend) or #2/16 (16 x 30) filter packs. Wells with a large proportion of coarser-grained material (e.g., medium sand and gravel) will be completed using 0.020-inch (20–slot) screen and #3 (8 x 20 blend) filter pack.

- The filter pack will be placed in the borehole annulus from the total depth to at least three feet above the top of the well screen. The sonic vibration during removal of the drive casing will consolidate the filter pack prior to placement of the annular seal.

- A three to five-foot thick bentonite seal will be placed above the top of the filter pack. Bentonite pellets with time-release coating, which are believed to be the most suitable bentonite sealant for use in deep well sealing, will be used and hydrated according to manufacturer's directions. The borehole annulus will then be grouted up to ground surface. The grout will consist of neat cement with approximately 5 percent bentonite.

- All the wells will be capped with a water-tight seal and locked. Wellheads will be completed at-grade in water-tight, traffic-rated vaults set in concrete. Well identification numbers will be stenciled onto the exterior of the protective casing.

3.2 Soil Sampling Procedures

3.2.1 Sampling and Analytical Methods

Soil samples will be collected from each hydrostratigraphic unit (UBF, B-Sand, MBFM, C-Sand, and LBF) encountered during drilling and analyzed as described below.

- Samples collected from the top and middle of the aquitards (UBF, MBFM, and LBF, as appropriate) and from the middle of the water-bearing zones (B-Sand, C-Sand, and Gage) will be analyzed for VOCs by EPA Method 8260B and total organic carbon (TOC) by EPA Method 9060 or equal.

- Samples collected from the middle of the aquitards (where encountered) will be analyzed for the following parameters:

    - Bulk density by API RP40/ASTM D2937

    - Vertical hydraulic conductivity by EPA Method 9100/ASTM D5084; and

    - Moisture content by ASTM D2216

The depth intervals for sample collection will be based on lithologic observations during drilling. In addition, boring logs from nearby wells will also be consulted to confirm the observed lithology and aid in the collection of samples from the appropriate hydrostratigraphic unit.

Prior to coring, the split-spoon sampler will be advanced ahead of the drive casing to the desired depth into the formation by use of a weighted hammer. Samples for laboratory analyses will be collected in stainless steel sleeves prior to coring because the heat generated by sonic driven advancement could potentially volatize contaminants. Samples for VOCs will be collected in accordance with EPA Method 5035 using Encore™ or equivalent sampler, or placed into preservative-filled sampling containers.

3.2.2 Field Screening

Soil cores will be observed for signs of contamination based on visible staining or discoloration and the presence of unusual odors. A portion of the soil samples collected at each sample depth from each boring will also be screened in the field for organic vapors. Field headspace screening will be performed using an organic vapor monitor (OVM) fitted with a photoionization detector (PID). A portion of the soil samples will be placed inside resealable plastic bags and left to equilibrate for approximately five to ten minutes. The PID probe tip will then be inserted inside each bag and the material screened for organic vapors. Field screening results will be recorded on the borehole logs.

3.2.3 Boring Log Preparation

During drilling and sampling, the onsite geologist will maintain a lithologic log of the continuous cores for each boring. The boring log will contain information on type of material encountered, color, moisture, density, gradation, and the presence of contamination based on visual staining and/or unusual odors. The log will also contain information regarding drilling conditions, blow counts, sampling intervals, sampling times, and sampling method. The onsite geologist will define the soil type using the visual Unified Soil Classification System (USCS) in accordance with American Society of Testing and Materials (ASTM) Method D2488-00.

3.3 Well Development

In accordance with California Well Standards, the proposed wells will be developed no sooner than 72 hours after installation. Wells will be developed by successive episodes of surging, bailing, or pumping. Surging is used to force fine-grained sediments out of the sand pack. Bailing or pumping is used to remove water containing suspended fine-grained material and to induce groundwater flow through the filter pack into the well. **Attachment A** contains standard operating procedures (SOPs) for well development. The following paragraph provides a brief summary of the well development procedures along with any key deviations from the SOPs.

The total depth of the wells will be measured before and after development activities to determine the presence or absence of sediments at the bottom of the wells. Wells will be developed using a combination of bailing, swabbing, surging, and over pumping. A turbidity meter will be used to monitor turbidity levels in water during development. Development will continue until water is relatively clear (no greater than 5 nephelometric turbidity units (NTU) and sediment free or until the onsite geologist deems that further development would be ineffective. The development water will be monitored periodically for temperature, electric conductivity (EC), and pH. Measurements will be recorded on well development forms included in **Attachment A**.

3.4 Groundwater Sampling and Analysis

Following well development and prior to the APTs, the wells will be sampled using the sampling and analysis procedures specified in the 2010 Groundwater Monitoring Work Plan (Avocet, 2010) for ongoing routine groundwater sampling events. It should be noted that depending on scheduling and access issues, well installation, sampling and of wells may happen at different times, with some wells being installed while APTs are being conducted at other wells.

A multi-parameter water quality instrument will be used to measure purge parameters (pH, dissolved oxygen [DO], oxidation-reduction potential [ORP], temperature, turbidity, and EC). A fixed laboratory will be used to analyze the samples for one or more of the following compounds:

- VOCs by EPA Method 8260B
- TOC by EPA Method 9060 or equal.

All samples for laboratory analysis will be stored on ice in a cooler and transported by courier to a California-certified analytical laboratory for analysis under proper chain-of-custody protocols. Chain-of-custody forms will be maintained throughout sample collection and transport. Field data will be collected and recorded on standard groundwater monitoring forms, and the laboratory data will be submitted electronically for upload to the project database in accordance with the accordance with Boeing's Data Management Plan (DMP).

Field quality assurance/quality control (QA/QC) sample collection and analyses and data validation of primary samples will be in accordance with the 2010 Groundwater Monitoring Work Plan.

3.5 Surveying

A licensed land surveyor will survey the locations and wellhead and ground surface elevations using the California State Plane Zone 5 Coordinates, North American Datum of 1983 (NAD 83) and North American Vertical Datum of 1988 (NAVD 88) to the nearest 0.01 foot. Wellhead elevations at a mark or notch on the north side of the well casing will be measured to the nearest 0.01 foot.

3.6 Equipment Decontamination

All reusable field equipment will be decontaminated before coming into contact with any sample. Equipment used for drilling operations and sample collection will be decontaminated before first use and between use at each well location. Large-scale decontamination will consist of thorough cleaning using high-pressure steam cleaner and potable water. For small, hand-held equipment, the "triple-rinse" method shall be used as follows:

- Ample amounts of tap water with a detergent (Alconox or equivalent) and a stiff brush will be used to wash reusable sampling equipment, which will be rinsed thoroughly with tap water, checked for any residual dirt, and rewashed if necessary.
- The item will be rinsed twice with tap water, followed by a final distilled water rinse.

- The item will be allowed to air dry and will be covered or wrapped in clean plastic, if not immediately used.

All equipment decontamination procedures will be recorded in the field logbook/data sheets. Decontamination liquids will be stored onsite pending laboratory analyses and final disposition as described in Section 3.8.

3.7 Investigation Derived Waste (IDW) Management

Investigation-derived waste (IDW) generated during field activities will include: soil, water, and solid waste. All investigation-derived waste will be handled in accordance with applicable local, county and state ordinances.

IDW consisting of soil drill cuttings, and decontamination, development, and purge water will be containerized, labeled, characterized, and properly stored pending laboratory analyses and disposal determination. Soil cuttings will be placed in 55-gallon drums or roll-off bins on-site pending profiling and disposal at a suitable off-site facility. All non-APT water (decontamination, development, and purge water) will be either stored in 55-gallon drums and/or Baker tanks on-site pending profiling and disposal at a suitable off-site facility.

Used personal protective equipment (PPE) including gloves, Tyvek suits, respirator cartridges, disposable filters, and other miscellaneous items will be double-bagged using plastic trash bags and then disposed as solid waste. Items such as empty cement bags, wrapping materials, decontaminated pieces of well casing and screen will be placed directly into solid waste dumpsters. Items that appear to be contaminated with hazardous materials or wastes will be inserted into plastic bags and placed inside 55-gallon drums for subsequent disposal at an appropriate facility. The drums will be inventoried and labeled to indicate the origin (boring number) of the drum contents.

4.0 Aquifer Performance Tests

Attachment B contains SOPs for performing the APTs with the following sections providing a brief summary of the procedures along with any key deviations from the SOPs. **Table 2** provides a summary of the proposed APTs.

4.1 Long-Term APTs

It is proposed to conduct long-term APTs on four wells, EWC003, EWC004, EWB003, and EWG001 consisting of ½ day to one day step test followed by a 24 hour constant discharge test. These tests are described in the following sections.

4.1.1 Step Drawdown Test (Step Test)

Upon completion of well development and sampling, water levels in the wells will be allowed to recover overnight. A step test will be conducted at each of the above-mentioned wells to understand well efficiency and establish the sustainable rate for the constant discharge test. It is proposed to conduct the step tests as four, one-hour long steps for the B-Sand and C-Sand wells and four, two-hour steps for the Gage well due to the higher anticipated pumping rates. Based on previous testing of other wells at the Site, it is expected that the pumping rates for each step in the B-Sand well will be 2.5, 5, 7.5, and 10 gallons per minute (gpm). Based on available data, the pumping rates for each step in the C-Sand wells is expected to be 5, 10, 15, and 20 gpm, while the pumping rates in the Gage aquifer well is expected to be 20, 40, 60, and 80 gpm. Pumping rates and times may be adjusted in the field depending on the amount of drawdown in the well and the time until water level stabilization.

4.1.2 Constant Discharge Test

A constant discharge test will be conducted at each well following the step test. Water levels will be allowed to recover to within 90 percent of the pre-step test level before commencing the constant discharge test, which will likely be overnight. Based on review of previous aquifer tests in the area (Hargis + Associates, Inc., 2008), and due to relatively low pumping rates, the constant discharge tests is expected to have a duration of approximately 24 hours. Based on available data, the expected pumping rate in the B-Sand well is 5 to 10 gpm, 10 to 20 in the C-Sand wells, and 50 to 80 in the Gage aquifer well. Actual pumping rates from the wells may be different depending on location-specific subsurface properties. Upon completion of the constant discharge tests, the water level recovery will be monitored for a period of 12 to 24 hours or until the water level in the pumping well has recovered to approximately 90 percent of the pre-step test level.

Water level response during the constant discharge test will be monitored in multiple observation wells in the B-Sand, C-Sand, and Gage aquifer. The observation wells for each constant discharge test and their approximate distances to the pumping well are listed in **Table 2**. **Figures 3, 4 and 5** show the proposed observations wells associated with each of the pumping wells for B-Sand, C-Sand, and Gage aquifer, respectively.

4.2 Short-Term APTs

In addition to the above-mentioned tests, short-term APTs will be conducted in four of the new wells, IWC003, IWC004, IWB001, and IWB002, and one existing B-sand well, MW0005. The purpose of these short-term APTs will be to provide additional hydrogeological data at these locations.

After the new wells are developed and sampled, the water levels will be allowed to recover overnight. A short-term (approximately 4 hours) constant discharge test will be conducted in the five wells (four new and one existing). The pumping rate will be determined during development. A transducer will be installed in the pumping well to monitor water levels. At the end of the test, the recovery in each well will be monitored overnight.

Figures 3, 4 and 5 show the proposed wells where the short-term APTs will be conducted for B-Sand, C-Sand, and Gage aquifer, respectively.

4.3 APT Water Analytical Testing

During the constant discharge test, analytical groundwater samples will be collected from each pumping well for VOC analyses (EPA 8260b) over time (for e.g. 4 hrs and 24 hrs for a 24 hour pump test or some similar intervals) to monitor the VOC trends and analyses of other appropriate compounds for evaluating groundwater treatment and treated water discharge-related options associated with the proposed remedy.

4.4 APT Data Collection

The majority of the drawdown data will be collected by data loggers/transducers. Mini trolls and/or level trolls manufactured by In-Situ, Inc. will be used to collect the data. Water levels will also be manually collected periodically, recorded, and compared to the transducer data to confirm that the transducers are operating correctly. The data from the transducers will also be uploaded to a computer at least once a day for data protection purposes.

4.5 Disposition of APT Water

The discharge water from the APTs will be stored on site in Baker tanks during the aquifer testing. Samples of the water will be analyzed to VOCs and other constituents as appropriate to determine the most appropriate disposal option(s).

5.0 Data Evaluation and Reporting

The data collected during the APTs will be analyzed using the software package Aquifer Win 32. Both drawdown and recovery data will be analyzed to determine the ranges of transmissivity, hydraulic conductivity, and storativity.

At the conclusion of field activities and APT data evaluation, a final summary report will be prepared that documents the field methodologies and results of well installation, sampling, and APTs; documentation of APT data analyses and calculations including raw drawdown/recovery data; and conclusions and recommendations for future work, as appropriate.

6.0 Project Schedule

The final summary report documenting the work will be submitted by September 30,2010.

7.0 References

Avocet Environmental, Inc. 2010. *2010 GROUNDWATER MONITORINGWORK PLAN, Boeing Former C-6 Facility, 19503 South Normandie Avenue, Los Angeles, California.* February 15, 2010.

California Regional Water Quality Control Board, Los Angeles Region (LARWQCB). 2007. *Waste Discharge Requirements for Pilot Tests to Evaluate Bioremediation of Volatile Organic Compounds (VOCs) in Groundwater, Boeing Realty Corporation, Former C-6 Facility, 19503 South Normandie Avenue, Los Angeles, California (File No. 95-036; SLIC NO. 410; Site ID No. 1846000).* August 10, 2007.

California Regional Water Quality Control Board, Los Angeles Region (LARWQCB). 2008. *Approval of Revised Monitoring and Reporting Program CI-9310, Individual Waste Discharge Requirements Order No. R4-2007-0040, Boeing Corporate Real Estate, Former C-6 Facility, 19503 South Normandie, Los Angeles, California (File No. 95-036; SLIC No. 0410; Site ID No. 1846000).* August 22, 2008.

Hargis + Associates, Inc. 2008. *Pilot Extraction and Aquifer Response Test Completion Report, Montrose Site, Torrance, California, DSGWRD 26 - 037.* April 30, 2008.

8.0 Limitations

This document was prepared by CDM, under the professional direction and review of the registered professional(s) listed. The work described herein was conducted in accordance with generally accepted professional engineering and geologic practice. No other warranty exists, either expressed or implied.

In addition to observations made by CDM personnel, this document incorporates Site conditions observed and described by others as reported in records available to CDM as of the date of document preparation. CDM relied—in part—on such data collected by others in the evelopment of interpretations about environmental conditions at the Site. The accuracy, precision, or representative nature of data originally generated by others could not be independently verified by CDM, and would be beyond the scope of this project.

In addition, the passage of time may result in changes to Site conditions, technology, or economic conditions which could alter the findings and/or recommendations of the document.

Please do not hesitate to contact the undersigned at 949-752-5452, if you have any questions.

Very truly yours,

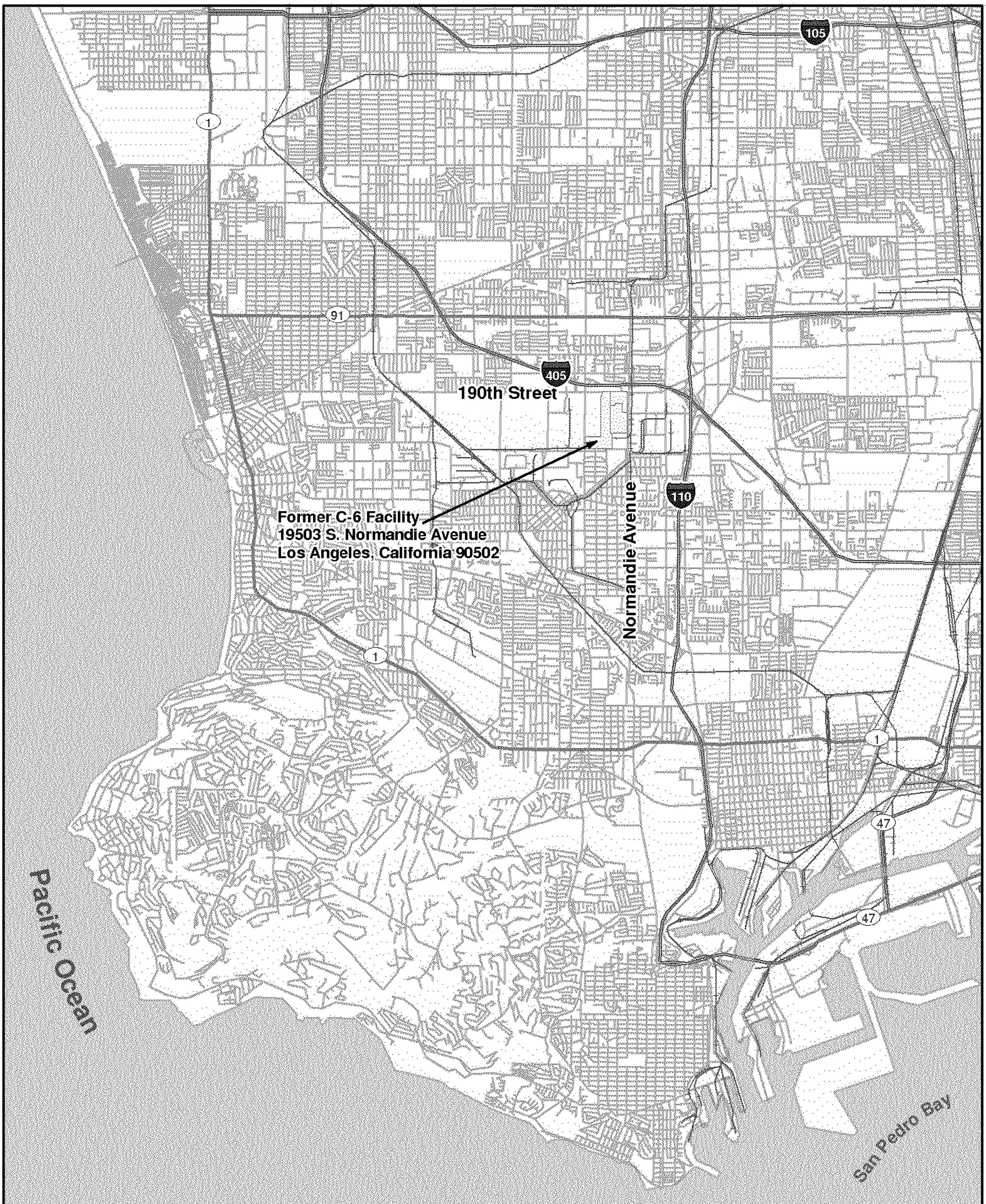
Michael J. Hoffman, C.HG.
Project Hydrogeologist

Ravi Subramanian, P.E
Principal and Project Manager

Attachments

Figure 1	–	Site Vicinity Map
Figure 2	–	Site Plan and Proposed B-Sand, C-Sand and Gage Aquifer Well Locations
Figure 3	–	Proposed APT Plan – B-Sand
Figure 4	–	Proposed APT Plan – C-Sand
Figure 5	–	Proposed APT Plan – Gage Aquifer
Table 1	–	Proposed Well Completion Details
Table 2	–	Summary of Proposed Aquifer Performance Tests (APTs)
Attachment A	–	Standard Operating Procedures (SOPs) for Well Development
Attachment B	–	Standard Operating Procedures (SOPs) for Aquifer Performance Tests

cc: Robert P. Scott, Boeing Company
Joe Weidmann, Haley &Aldrich, Inc.
Michael Smith, CDM



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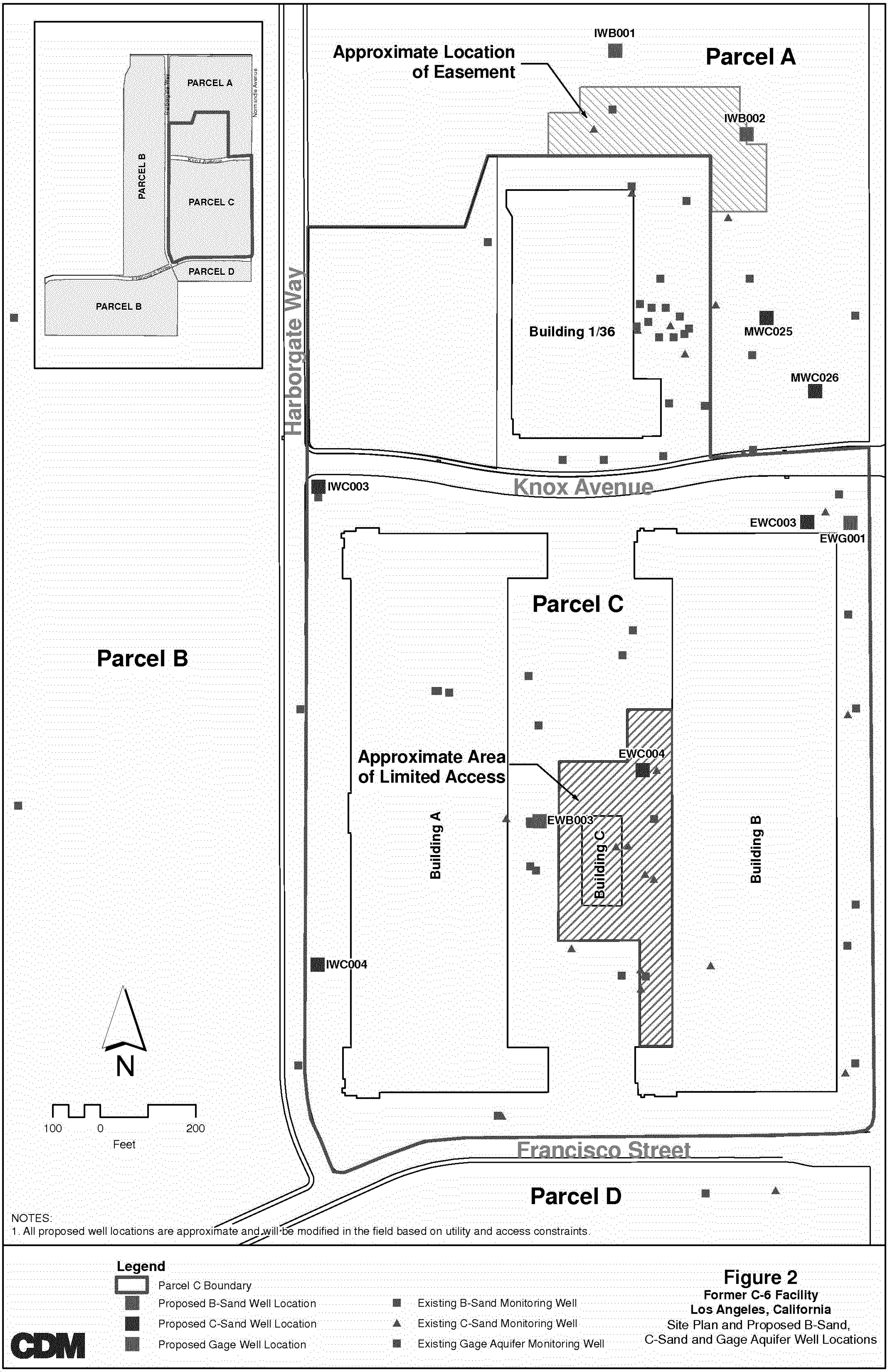
The Boeing Company
Former C-6 Facility

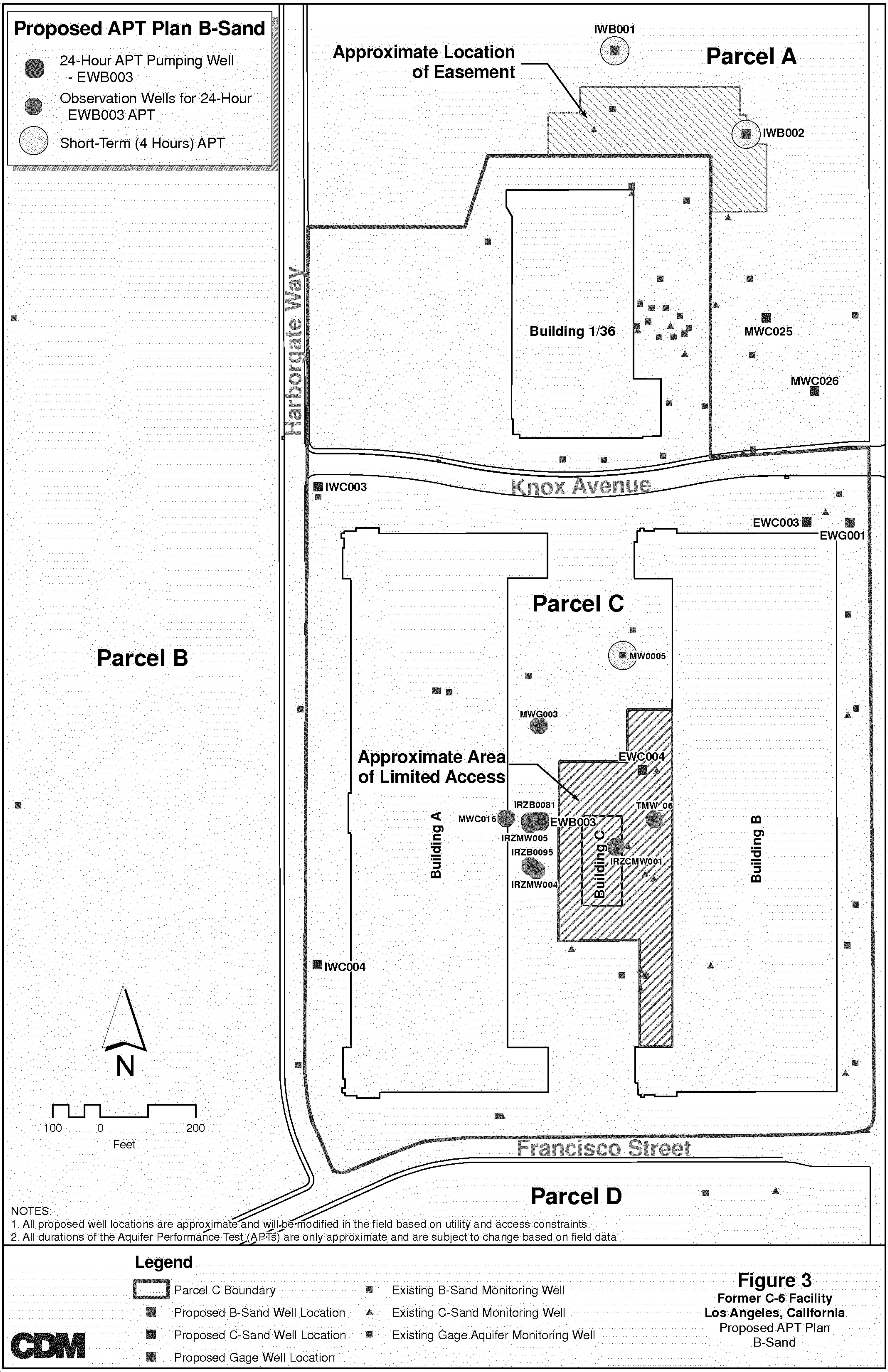
Site Vicinity Map

Figure 1



NOTES:
1. All proposed well locations are approximate and will be modified in the field based on utility and access constraints.

Figure 2
Former C-6 Facility
Los Angeles, California
Site Plan and Proposed B-Sand, C-Sand and Gage Aquifer Well Locations



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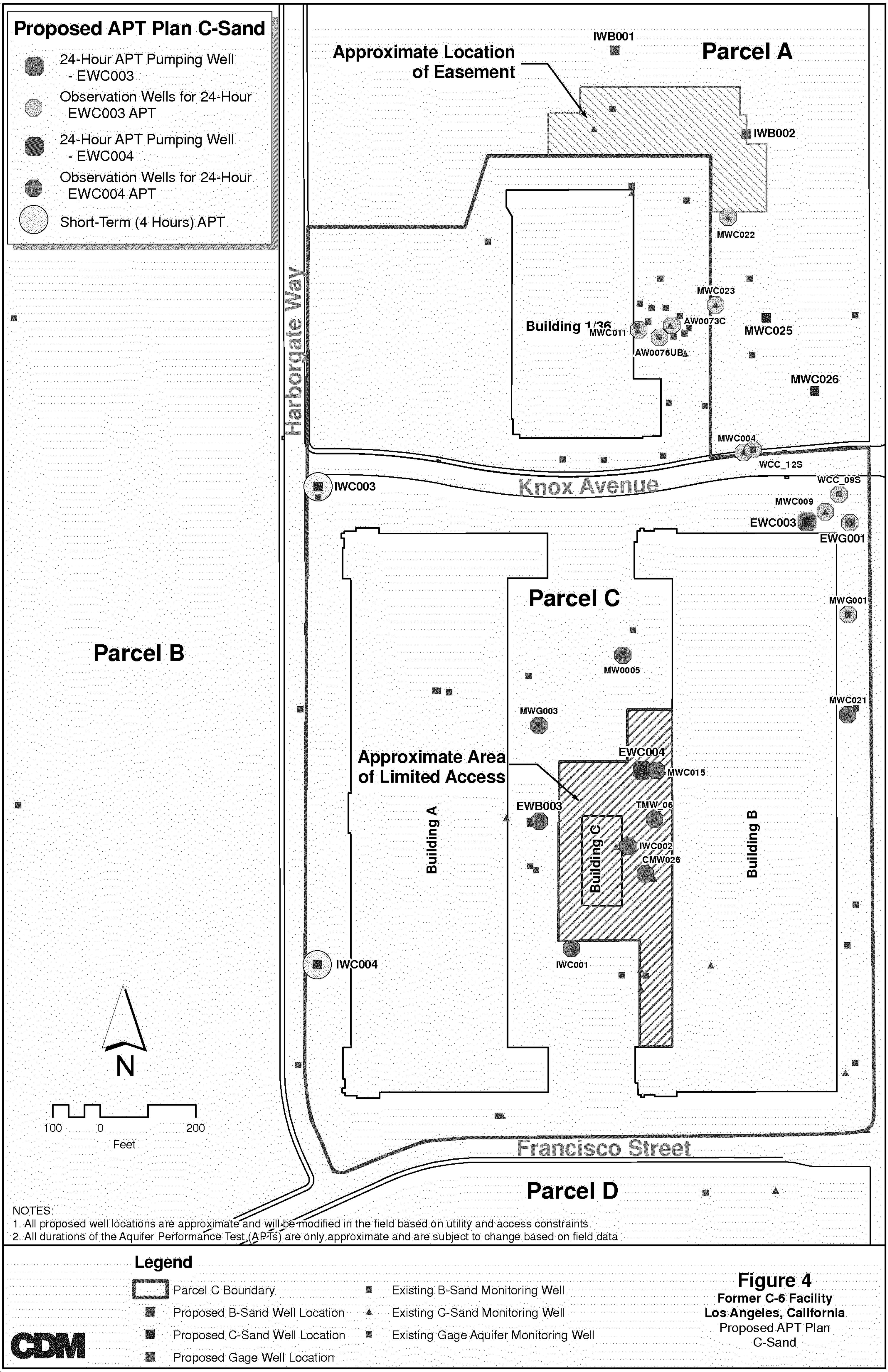
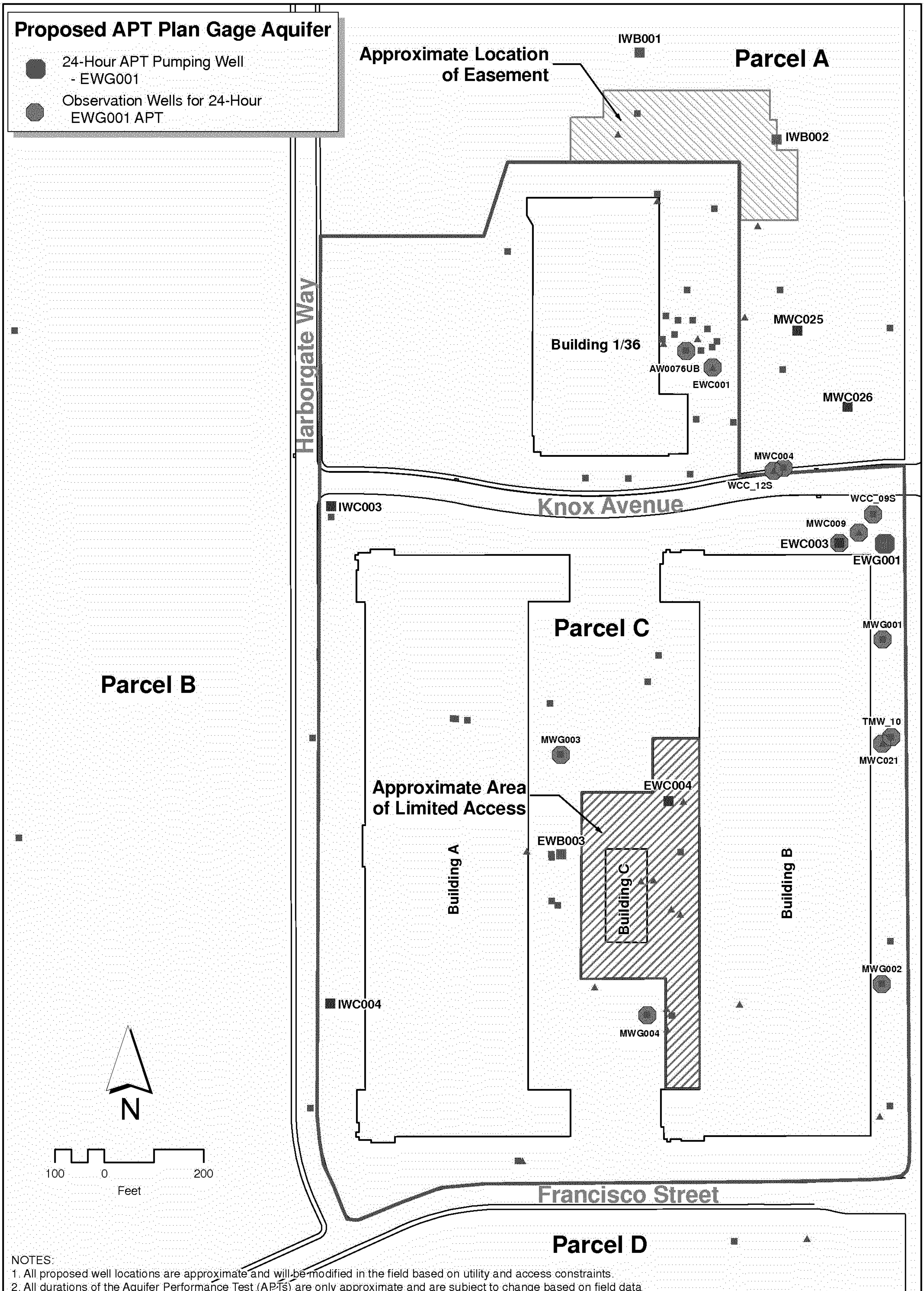


NOTES:
1. All proposed well locations are approximate and will be modified in the field based on utility and access constraints.
2. All durations of the Aquifer Performance Test (APTs) are only approximate and are subject to change based on field data

Figure 4
Former C-6 Facility
Los Angeles, California
Proposed APT Plan
C-Sand



NOTES:
1. All proposed well locations are approximate and will be modified in the field based on utility and access constraints.
2. All durations of the Aquifer Performance Test (APTs) are only approximate and are subject to change based on field data

Legend

- Parcel C Boundary
- Proposed B-Sand Well Location
- Proposed C-Sand Well Location
- Proposed Gage Well Location
- Existing B-Sand Monitoring Well
- Existing C-Sand Monitoring Well
- Existing Gage Aquifer Monitoring Well

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Figure 5
Former C-6 Facility
Los Angeles, California
Proposed APT Plan
Gage Aquifer

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Table 1
Proposed Groundwater Well Completion Details
Former C-6 Facility, Los Angeles, California

Well ID	Purpose	Easting[(1)]	Northing[(1)]	Reference Elevation (feet amsl)[(2)]	Estimated Boring Total Depth (feet)[(3)]	Estimated Screen Depth Interval (feet)[(3)]	Top of Filter Pack (feet above top of screen - minimum)	Casing & Screen Diameter (inches)	Casing Type	Screen Type	Anticipated Slot Size (inches)[(4)]
B-Sand Wells											
EWB003	Collection of hydrogeologic parameters in B-Sand	TBD	TBD	TBD	92	60 - 90	3	5	Sch 40 PVC	SS Wire Wrap	0.01 or 0.02
IWB001	Collection of additional hydrogeologic, soil, and groundwater data from B-Sand	TBD	TBD	TBD	92	60 - 90	3	5	Sch 40 PVC	SS Wire Wrap	0.01 or 0.02
IWB002	Collection of additional hydrogeologic, soil, and groundwater data from B-Sand	TBD	TBD	TBD	92	60 - 90	3	5	Sch 40 PVC	SS Wire Wrap	0.01 or 0.02
C-Sand Wells											
EWC003	Collection of hydrogeologic parameters in C-Sand	TBD	TBD	TBD	125	95 - 120	3	5	Sch 40 PVC	SS Wire Wrap	0.01 or 0.02
EWC004	Collection of hydrogeologic parameters in C-Sand	TBD	TBD	TBD	125	95 - 120	3	5	Sch 40 PVC	SS Wire Wrap	0.01 or 0.02
IWC003	Collection of additional hydrogeologic, soil, and groundwater data from C-Sand	TBD	TBD	TBD	125	95 - 120	3	5	Sch 40 PVC	SS Wire Wrap	0.01 or 0.02
IWC004	Collection of additional hydrogeologic, soil, and groundwater data from C-Sand	TBD	TBD	TBD	125	95 - 120	3	5	Sch 40 PVC	SS Wire Wrap	0.01 or 0.02
MWC025	Collection of additional soil and groundwater data from C-Sand	TBD	TBD	TBD	125	95 - 120	3	2	Sch 40 PVC	Sch 40 PVC	0.01 or 0.02
MWC026	Collection of additional soil and groundwater data from C-Sand	TBD	TBD	TBD	125	95 - 120	3	2	Sch 40 PVC	Sch 40 PVC	0.01 or 0.02
Gage Wells											
EWG001	Collection of hydrogeologic parameters in Gage	TBD	TBD	TBD	195	160 - 190	4	5 or 6	Sch 80 PVC	SS Wire Wrap	0.01 or 0.02

Notes:
All wells are proposed to be drilled by sonic rotary drilling
(1) Final coordinates of the well will be based on California State Plane North American Datum of 83 (NAD 83), Zone 5, Feet
(2) feet amsl = feet above mean sea level; final elevations will be based on North American Vertical Datum of 1988 (NAVD 88)
(3) Final boring and screened depths and screen intervals will be based on lithologic observations.
(4) The final screen slot size for all the wells will be selected on a case by case basis, based on the lithology encountered and gradation of the chosen filter pack

Table 2
Summary of Proposed Aquifer Performance Tests
Former C-6 Facility, Los Angeles, CA

Pumping Wells				APT Observation Wells			
Well ID	Exist or New Well?	Type of Test	Selection Rationale	Well ID	Exist or New Well?	Purpose	Approx. Distance to Pumping Well (ft)
C-Sand (MFBC) APTs							
EWC003	**NEW**	**Long-term APT**	Collect hydrogeologic parameters at designated wells. Facilitate model development	MWC009		MFBC Monitoring	45
		Step Test		MWC004			190
		4 steps @1 hr/ea		MWC023			488
		5, 10, 15, 20 gpm		AW0073C			503
		Const Discharge Test - 24 hrs @ 10 - 20 gpm		MWC011			531
				MWC022			655
				WCC_09S		MBFB Monitoring	89
				WCC_12S			181
				AW0076UB			499
				EWG001	**NEW**	Gage Monitoring	91
				MWG001			221
EWC004	**NEW**	**Long-term APT**	Collect hydrogeologic parameters at designated wells. Facilitate model development	MWC015		MBFC Monitoring	35
		Step Test		IWC002			162
		4 steps @1 hr/ea		CMW026			225
		5, 10, 15, 20 gpm		IWC001			404
		Const Discharge Test - 24 hrs @ 10 - 20 gpm		MWC021			449
				TMW_06		MBFB Monitoring	114
				MW0005			238
				EWB003	**NEW**		241
				MWG003		Gage Monitoring	231
IWC003	**NEW**	Short-term Well Testing (4 hours pumping followed by recovery monitoring)	Collect additional hydrogeological data at designated well locations	None	These tests would consist of pumping the wells at the maximum sustainable rate for a period of approximately four hours during which drawdown and recovery data will be measured with a transducer in the pumping well		
IWC004	**NEW**	Short-term Well Testing (4 hours pumping followed by recovery monitoring)	Collect additional hydrogeological data at designated well locations	None	These tests would consist of pumping the wells at the maximum sustainable rate for a period of approximately four hours during which drawdown and recovery data will be measured with a transducer in the pumping well		

Table 2
Summary of Proposed Aquifer Performance Tests
Former C-6 Facility, Los Angeles, CA

Pumping Wells				APT Observation Wells			
Well ID	**Exist or New Well?**	**Type of Test**	**Selection Rationale**	**Well ID**	**Exist or New Well?**	**Purpose**	**Approx. Distance to Pumping Well (ft)**
B-Sand (MBFB) APTs							
EWB003	**NEW**	**Long-term APT** *Step Test 4 steps @1 hr/ea 2.5, 5, 7.5, 10 gpm* *Const Discharge Test - 24hrs @ 5 - 10 gpm*	Collect hydrogeologic parameters at designated wells. Facilitate model development	IRZB0081		MBFB Monitoring	18
				IRZMW005		MBFB Monitoring	20
				IRZB0095		MBFB Monitoring	103
				IRZMW004		MBFB Monitoring	111
				TMW_06		MBFB Monitoring	246
				MWC016		MBFC Monitoring	66
				IRZCMW001		MBFC Monitoring	175
				MWG003		Gage Monitoring	194
MW0005	EXISTING	Short-term Well Testing (4 hours pumping followed by recovery monitoring)	Collect additional hydrogeological data at designated well locations	None	These tests would consist of pumping the wells at the maximum sustainable rate for a period of approximately four hours during which drawdown and recovery data will be measured with a transducer in the pumping well		
IWB001	**NEW**	Short-term Well Testing (4 hours pumping followed by recovery monitoring)	Collect additional hydrogeological data at designated well locations	None	These tests would consist of pumping the wells at the maximum sustainable rate for a period of approximately four hours during which drawdown and recovery data will be measured with a transducer in the pumping well		
IWB002	**NEW**	Short-term Well Testing (4 hours pumping followed by recovery monitoring)	Collect additional hydrogeological data at designated well locations	None	These tests would consist of pumping the wells at the maximum sustainable rate for a period of approximately four hours during which drawdown and recovery data will be measured with a transducer in the pumping well		

Table 2
Summary of Proposed Aquifer Performance Tests
Former C-6 Facility, Los Angeles, CA

Pumping Wells				APT Observation Wells			
Well ID	**Exist or New Well?**	**Type of Test**	**Selection Rationale**	**Well ID**	**Exist or New Well?**	**Purpose**	**Approx. Distance to Pumping Well (ft)**
Gage APTs							
EWG001	**NEW**	**Long-term APT** *Step Test* *4 steps @2 hrs/ea* *20, 40, 60, 80 gpm* *Const Discharge Test - 24 hrs @ 50 - 80 gpm*	Collect hydrogeologic parameters at designated wells. Facilitate model development.	MWG001		Gage Monitoring	200
				MWG003			782
				MWG002			897
				MWG004			1071
				MWC009		MBFC Monitoring	51
				EWC003	**NEW**		91
				MWC004			262
				MWC021			410
				EWC001			498
				WCC_09S		MBFB Monitoring	64
				WCC_12S			248
				TMW_10			398
				AW0076UB			562

Attachment A
Standard Operating Procedures (SOPs) for Well Development

Attachment A
Standard Operating Procedures (SOPs) for Well Development

General

Upon completion of construction, wells will be allowed to sit for approximately 72 hours prior to development to allow the seal to set. The well shall be developed until the water pumped from the well is substantially free from sand and until the turbidity is less than 5 nephelometric turbidity units (NTU). Developing equipment shall be of sufficient capacity to remove all cutting fluids, sand, rock cuttings, and any other foreign material. The well shall be thoroughly cleaned from top to bottom before beginning the well tests. Development shall be performed using a combination of bailing, swabbing, surging, and over pumping, per ASTM D 5521. At the time of development of any well, the well shall be free of drawdown or surcharge effects due to pump testing, developing, or drilling at another location.

Development Procedures

Well development will then be completed by a combination of bailing, swabbing, surging, and pumping to grade the filter pack and native formation materials adjacent to the well screen and remove fine materials from inside the casing. Well development will be completed in accordance with the following steps:

1. Record the static water level and total well depth including depth of sediments/fines.

2. Begin surging using a properly designed surge block and proper surging technique. Surging of the well shall require use of a circular block, or multiple blocks, approximately ¼-inch smaller in diameter than the inside diameter of the well and constructed of a material which will not damage the screen if the block comes in contact with the screen, and a bailer or pump to remove materials drawn into the well. The surging shall be continued for until little or no additional material from the formation or filter pack can be pulled through the screen. The surge block shall be moved by a steady motion up and down the full length of the well screen. Prior to commencing surging, and periodically during development by this method, all sand and/or other materials shall be bailed from inside the screen.

3. Measure and record well depth to determine the amount of fines, and repeat Step 2 until sand is no longer pulled into the well.

4. The final stage of development shall consist of pumping with a submersible pump. A pump with appropriate discharge capacity to match the anticipated pumping rate from the various aquifers will be required. The intake shall be set at least 10 feet below the maximum expected drawdown in the well. Prior

to commencing pumping all sand and/or other materials shall be removed from inside the well. The amount of drawdown may be decreased if, in the opinion of the onsite geologist, the efficiency of the well might otherwise be impaired.

During development, pH, temperature, turbidity, and electric conductivity (EC) of water removed from the well will be measured using calibrated field instruments. These field parameters will be measured at frequent intervals during development and will be recorded in the field notebook and the attached well development log along with visual observations of the clarity and color of water produced.

Water removed during development and testing operations shall be contained in DOT-approved 55-gallon drums, Baker tanks, or other suitable containers onsite and disposed of in accordance with project-specific requirements.

Development Completion Criteria

Development will be considered complete when ALL of the following criteria are met:

- Well water is clear to the unaided eye with turbidity less than 5 NTU.
- Sediment thickness in the well is less than 1 percent of the screen length.
- A minimum of three times the standing water volume in the well is removed plus three times the volume of all added water and drilling fluid lost (if applicable) during drilling and installation of the well is removed.
- Turbidity and pH readings, measured before, twice during, and after development operations, have stabilized in three successive readings (with one casing volume of water removed between each reading) to within variances shown below:

Parameter	Variance
Turbidity	± 10%
pH	± 0.1 pH units

Well No.:	Site/Location:		
Client:	Contractor:		Page______ of ______
Date Started:		Time Started:	Development Rig: (Y / N)
Date Ended:		Time Ended:	Casing Diameter:
Equipment:		Pre-devel. Static Water Level (feet BTOC):	
Development Method:		Average discharge rate (gpm):	
Maximum Drawdown During Pumping: ____________ feet at ____________ gpm		Total Quantity Bailed (gallons):	
		Total Quantity Pumped (gallons):	
		Developed By:	

Total Depth of Well (feet): ___________

Depth to Water (feet): ________ x Conv Factor = ______________ 1 Casing Volume (gals)

Water Column Height (feet): ___________

Conv Factors (gal/foot)

For 2" Well = 0.16
For 4" Well = 0.65
For 5" Well = 1.02
For 6" Well = 1.47

Time	Gallons	Temp. (°C / °F)	pH	Conductivity (µmhos/cm)	Turbidity (NTUs)	Water Level (ft. BTOC)	Remarks

CDM

WELL DEVELOPMENT LOG

Attachment B
Standard Operating Procedures (SOPs) for Aquifer Performance Tests

CDM

Attachment B
Standard Operating Procedures (SOPs) for Aquifer Performance Tests

General

The purpose of this standard operating procedure (SOP) is to define requirements for conducting standard aquifer performance tests (APTs). The information collected during an APT is used for defining the hydraulic characteristics of the aquifer. Data collected during an APT can also be used to assess pump selection and water delivery piping.

In general, APTs consist of withdrawing water from a pumping well for a specified time period and monitoring the water level in the pumping well and observation wells. The recorded time-drawdown data are then reduced and analyzed to:

- Determine the specific capacity and safe yield of the well
- Calculate the properties (transmissivity [T] and storativity [S]) of the aquifer. T may be estimated from pumping well and observation well data; S may be estimated from observation well data
- Characterize the hydrogeologic framework at and near the investigation area

These three items, or one of the items at a minimum, are typically evaluated with APT data. However, other ancillary but useful information (e.g., water quality changes under stressed conditions) may also be obtained from the APT data.

Suggested Equipment

Water Measuring and Recording

- Pressure transducers and data logger
- Personal computer for viewing and downloading data
- Water level measuring device
- Stopwatch
- Field logbook
- Decontamination equipment and supplies
- Data on construction of the pumping well (depth to screen and screen length)

Water Pumping and Handling

- Pump (sufficient capacity to withdraw at the required rate) with electric wiring

- Discharge hosing/piping
- Electrical source (e.g., generator)
- Flowmeter with totalizer
- Sampling valve
- Water treatment unit (if required)
- Water storage container (if required)
- Ancillary equipment and supplies to install and/or operate the main equipment

Procedures

An APT has four main components:

1. Preparation
2. Continuous background monitoring
3. Step drawdown test
4. Long-term constant discharge test

A form that provides typical general information that should be recorded for each test is provided at the end of this SOP.

Preparation

Adequate attention to the planning and design of the APT is a significant phase of the procedure and will ensure that useful results are produced. A planning meeting shall be held to identify the objectives of the APT and discuss the detailed scope and procedures to be followed for each component of the APT.

Continuous Background Monitoring

Water levels shall be collected continuously prior to performing the APT. As appropriate, adjacent surface water bodies should also be monitored if the surface water is potentially connected to the groundwater system. The water levels shall be used to reduce and analyze the data collected during the APT. The background data is also useful in characterizing the hydrogeologic framework.

Transducers/loggers shall be installed in the pumping well and the observation wells. Each transducer/logger shall be checked and set following the manufacturer's manual, including setting the internal clock to a common external standard. Each transducer shall be installed to a depth that does not exceed the working capacity of the transducer and where the water level will not drop below the transducer during ambient water level changes. After the selected depth is reached with the transducer, perform the following steps:

- Securely attach the cable to the well head and mark a reference point with electrical tape to allow verification that the transducer position does not change during the test

- Read the depth of water using the transducer (note that the transducer may need to equilibrate with the water temperature following the manufacturer's specifications and recover from displacement of water caused by submersion of the transducer)

- Collect a manual water level measurement from the well's measuring point

- Begin recording water levels on a linearly rate of 1 reading per 30 minutes

Transducers shall be programmed so that water level recording begins at the same time at each well. Having water levels recorded at the same time for each well simplifies the data reduction and evaluation activity contrasted to having water levels recorded at different times for different wells.

Background water levels shall be recorded for a suitable period of time as determined by the project needs. During the monitoring period, the transducers/loggers should be occasionally checked, as appropriate, to verify that the equipment is working properly. Manual water level measurements should be taken and recorded during this check. Replace any transducer that is identified to be not operating correctly.

At the end of the monitoring period, stop the test recording and download the recorded data.

Barometric pressure (BP) and precipitation shall be recorded during the background monitoring period. These two elements are commonly considered the main natural factors to impact groundwater levels. If publicly available data can be obtained from a weather station located nearby (within approximately 5 miles of the project), the data from that station may be used. BP and precipitation data shall also be recorded during the constant discharge test.

Step Drawdown Test

The step drawdown test (or simply, step test) is required to determine the constant pumping rate that will be used for the subsequent long-term constant discharge test and to assess well efficiency. Step test data may also be used to evaluate the hydrogeologic characteristics. The step test is performed at the pumping well. In summary, the step drawdown test consists of pumping water from the well at short incrementally increased rates (steps) so that a withdrawal rate can be determined for the long-term test.

A pump capable of yielding 1.5 times the estimated yield of the pumping well shall be installed to the specified depth. A vertical check valve will be placed in the discharge line immediately above the pump or intake to prohibit water from draining into the well when the pumping ceases. A 1-inch diameter PVC line will be placed in the well with the bottom end open to a depth within 1 foot from the top of the pump. Several ¼-inch diameter holes should be drilled in the bottom 5 feet of this stilling pipe. The water level transducer will be installed in the pipe. After the pumping equipment and transducer are installed, the following steps will be followed:

- Connect a flow meter/totalizer and sample tap with valve to the discharge line from the pump; direct the discharge line to the system to handle the water. Care must be taken to provide sufficient straight sections of pipe above and below the flow meter to obtain accurate measurements. Recent calibration certificates should be obtained for the flow meter.
- Record the volumetric reading on the totalizer (Note: Prior to pumping and increasing pumping rate and after ending pumping, the volumetric reading should be recorded).
- Measure and record the static water level in the pumping well.
- Begin logging with the transducer and then start pumping water from the pumping well at a relatively low (approximately ½ of the estimated yield) but steady rate (STEP 1); logging should be started approximately 2 to 5 seconds prior to starting pumping. Flow should be adjusted to maintain a constant rate, noting when changes are made.
- Record the time at which pumping is started, using a clock that is synchronized with the transducer clocks, and the flow rate; check operation of the transducer.
- Monitor the water level in the pumping well with the transducer and confirm periodically with manual measurements.
- After approximately 1½ hours, increase the pumping rate to approximately ¾ of the estimated yield, and continue to monitor the water level for approximately 2 hours (STEP 2).
- Record the time at which the pumping rate is increased and the new flow rate; check operation of the transducer.
- Approximately 2 hours after increasing the pumping rate for STEP 2, increase the pumping rate to approximately equal to the estimated yield, and continue to monitor the water level for approximately 2 hours (STEP 3).
- Record the time at which the pumping rate is increased and the new flow rate.
- Approximately 2 hours after increasing the pumping rate for STEP 3, increase the pumping rate to approximately 1.5 x the estimated yield, and continue to monitor the water level for approximately 2 hours (STEP 4).

- Record the time at which the pumping rate is increased and the new flow rate.

- Shut off the pump at the end of STEP 4 (maximum of 8 hours has elapsed since pumping started at the beginning of the test) and download data. The transducer should continue recording during the recovery period.

A step test is dynamic. During each step the operator will gain more information on how the well's water level responds to specified pumping rates. The estimated increases identified above for each step should only be used as a guide. Each successive increase should be based on the operator's general understanding of well hydraulics, observations made while installing and developing the well, and on the well's response during the previous step(s). The goal, in summary, is to achieve the well yield at STEP 3 and exceed the well yield at STEP 4.

During the test, water levels at the pumping well shall be recorded logarithmically following the recommended schedule in the following chart. Typical data loggers have default sample intervals except for the largest sample interval, which is set by the user (in the table below, the 10-minute sample interval is set by the user). The default sample intervals shall be equal to or similar to the table below.

Log Cycle	Elapsed Time	Sample Interval	Points/Cycle
1	0 to 20 seconds	0.2 second	101
2	20 to 60 seconds	1 second	40
3	1 to 10 minutes	10 seconds	54
4	10 to 100 minutes	2 minutes	45
5	100 to 1000 minutes	10 minutes	90

The drawdown-time data shall be plotted semi-logarithmically. The drawdown (y-axis) shall be plotted on a linear scale and time (x-axis) shall be plotted on a logarithmic scale. The drawdown curves shall be extrapolated to the specified time of the proposed long-term test. The rate that results in the maximum drawdown without dropping the water level below the design pumping level within the time period of the long-term test shall be considered the flow rate to be used for the long-term test. The specific capacity versus pumping rate should also be plotted to determine if excessive well losses occur at the selected rate.

Long-term Constant Rate Test

The long-term constant rate test will be performed at the pumping well. Water levels will be monitored in the pumping well and the observation wells. The same pumping equipment used for the step test will be used for the long-term test. BP and precipitation shall be recorded, as appropriate, during the long-term test. If publicly available data can be obtained from a weather station located nearby (within approximately 5 miles of the project), the data from that station may be used. As appropriate, adjacent surface water bodies should also be monitored if the surface water is potentially connected to the groundwater system.

The time interval for the long-term constant rate test shall be specific to the project needs and could vary from as little as 12 hours to five days (120 hours). The project objectives will need to be reviewed and aquifer test solution requirements considered so that the correct pumping period is selected. The following steps shall be followed to conduct the long-term test after the step test is completed.

- Install transducers in the pumping well and the observation wells (note that transducers can be installed in observation wells prior to the day the long-term test starts).

- Read the water level depths with the transducers and record the values; measure and record the static water levels with the electronic water level meter from the wells' measuring points.

- Record the volumetric reading on the totalizer.

- Begin logging water level data with the transducers and then start pumping at the predetermined rate (determined based on the step-drawdown test results).

- Periodically monitor discharge rate and transducers; maintain constant pumping rate.

- Stop pumping at the end of the specified time, record volumetric reading on the totalizer.

- Continue to record water level data with transducers until the water level in the pumping well has recovered so that sufficient data are collected to adequately analyze the recovery or a maximum of 24 hours has elapsed.

The water level data will be transferred to electronic form so that it may be reduced, analyzed, and put into report format.

The water levels in the wells will be recorded logarithmically following the recommended schedule in the following chart or something similar:

Log Cycle	Elapsed Time	Sample Interval	Points/Cycle
1	0 to 20 seconds	0.2 second	101
2	20 to 60 seconds	1 second	40
3	1 to 10 minutes	10 seconds	54
4	10 to 100 minutes	2 minutes	45
5	> 100 minutes	10 minutes	Unspecified

When the pump is shut off and recovery begins, a new logarithmic series will be started for the transducer in the pumping well. The series shall be started 1 to 5 seconds prior to ending the pumping activity. The transducers in the observation wells will continue to monitor on the first logarithmic cycle series. If the aquifer is expected to recover quickly, the observation well transducers may also be restarted on a new series. Data will be recorded until the water level in the pumping well has returned so that sufficient data are collected to adequately analyze the recovery or until a maximum of 24 hours has elapsed. A manual water level measurement shall be collected from the wells, measuring points, and a reading should be taken with the transducers during recovery.

At the conclusion of the recovery test, the data logging shall be stopped at each well and the transducers shall be removed and the data downloaded.

Data Reduction and Analyses

The data sets from APTs may be reduced and analyzed to:

- Determine the specific capacity and safe yield of the well
- Calculate the properties (T and S) of the aquifer
- Characterize the hydrogeologic framework at and near the investigation area

These three items, or one of the items at a minimum, are typically evaluated with APT data. Other pumping test data may also be available and evaluated. APT data are recommended to be analyzed with computer software; however, data may also be analyzed manually. The CDM groundwater modeling tool kit contains Aquifer^{Win32}, which is a program that may be used to assist in analyzing test data. Software packages are useful since they can be used to manage a significant amount of data in short time periods and contain many different confined and unconfined test solutions. The trained user can use these benefits to generate detailed response curve graphs, precise hydraulic values, and insights into the hydrogeologic framework near the well. Regardless of the analytical method employed or whether the data is analyzed manually or by computer, the analyst should review the original technical paper or textbook summary of the method in order to understand the mechanics and assumptions underlying the method prior to attempting any analysis and verify the method is appropriate for the site conditions.

References

American Society for Testing and Materials. 2004. *Standard Guide for Selection of Aquifer Test Method in Determining Hydraulic Properties by Well Techniques. D 4043-96* (Reapproved 2004).

__________ .2002. *Standard Test Method (Field Procedure) for Withdrawal and Injection Well Tests for Determining Hydraulic Properties of Aquifer Systems. D 4050-96* (Reapproved 2002).

Environmental Simulations, Inc. 2000. *Guide to Using Aquiferwin32.*

APT DATA FORM

Project Name:	**Date:**
Pumped Well ID:	**Weather:**
Observation Well ID:	**Personnel:**

Well Locations *(please attach map or sketch) Include: Scale/dimensions, north arrow, and significant features (e.g., surface water)*

This sheet records data for *(Well ID)* **:**	
Measuring Point:	(e.g. notch or inner casing)
Static Water Level:	(feet below measuring point [ft. BMP])
Static Water Level Date:	**Time:**
Interval Open/Screened to Aquifer (ft BMP):	
Pump Setting Depth (ft BMP):	
Pump Model:	**Serial No.:**
Flow Meter Model:	**Serial No.:**
Logger/Transducer Model:	**Serial No.:**
Totalizer Reading BEFORE Pumping:	**Totalizer Reading AT END of Pumping:**
Date/Time Pumping Started:	**Date/Time Pumping Ended:**
Discharge Rate (gpm):	

Date	Time	Manual Water Level Measurement (ft. BMP)	Discharge (gpm)	Comments

* Use more sheets as needed